

# **DSP-59+**

## **Audio Noise Reduction Filter**

### **Operating Manual**

Manual Version 3.1

**Timewave Technology Inc.**

# **Table of Contents**

<b>1. Introduction to the DSP-59+</b>	<b>2</b>
<b>2. Description of Controls and Connectors</b>	<b>2</b>
<b>3. Specification</b>	<b>5</b>
<b>4. Installation</b>	<b>7</b>
<b>5. Operation</b>	<b>9</b>
<b>6. Troubleshooting</b>	<b>16</b>
<b>7. Warranty</b>	<b>19</b>
<b>8. Electromagnetic Interference</b>	<b>20</b>
<b>9. Schematic Diagram</b>	<b>20</b>
<b>10. Appendix - Connector Requirements</b>	<b>23</b>

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# 1. Introduction to the DSP-59+

The DSP-59+ is an audio noise filter for amateur radio voice, data and CW operation. The DSP-59+ filters and reduces noise and interference to improve radio reception. The DSP-59+ uses digital signal processing technology to implement algorithms that perform four basic functions: 1) Random noise reduction, 2) Adaptive multi-tone notch filtering (Tone noise reduction), 3) Bandpass/Highpass/Lowpass filtering, and 4) RTTY remodulation.

## Random/Tone Noise Reduction

The noise reduction functions of the DSP-59+ operate by examining a characteristic of signals and noise called *correlation*, and dynamically filtering out the undesired signals and noise. The degree of correlation is relative. Random noise such as white noise or static is uncorrelated. Speech is moderately correlated. Repetitive noise such as a heterodyne is highly correlated. The DSP-59+ measures correlation and filters out signals and noise that are outside its correlation thresholds. The amount of noise reduction varies according to the correlation characteristics of the noise. Typical noise reduction ranges from 5 dB to 20 dB for random noise and up to 50 dB for heterodynes.

## Highpass/Lowpass Filters

The DSP-59+ has 15 highpass and 15 lowpass filters that are independently selectable from front panel controls. There are many uses for the 225 combinations of highpass and lowpass filters that the DSP-59+ offers. In a typical example of a voice mode application, highpass and lowpass filters can improve a signal with a poor signal-to-noise ratio. The independent highpass and lowpass filters remove the low and high audio frequency components that do not contribute significantly to the speech intelligibility, thus improving signal quality. Another common voice mode example is the improvement of a SSB signal corrupted by adjacent channel interference (QRM). The steep skirts of the highpass and lowpass filters allow the high side and low side interference to be eliminated independently with minimal impact on the desired signal. Although the DSP-59+ has bandpass filters for CW and the most common data modes, the 225 selectable highpass and lowpass filter combinations also allow precise filtering for modes such as wideshift RTTY. The DSP-59+ highpass filter adjustment range is from 200 to 1600 Hz. and the lowpass range is from 1700 to 3400 Hz.

## Bandpass Filters

The DSP-59+ has 316 bandpass filters that are used in data and CW modes. Narrow band signals like CW and RTTY require bandpass filters with steep skirts and linear phase response. Linear phase response maximizes the usable signaling rate for a given bandwidth and minimizes ringing often heard on extremely sharp filters. The DSP-59+ has 195 CW filters with skirts so steep that a signal literally falls off the edge of the passband as you tune through a CW signal. Bandwidths for these filters range from 25 Hz. to 600 Hz., and center frequencies from 400 to 1000 Hz. The narrow filters are useful for trying to dig out extremely weak signals from the noise and QRM. The wider filters allow easy tuning and listening to multiple CW signals simultaneously. Three

optional CW center frequencies may be internally programmed for older Collins KWM-2 and S-Line equipment.

The DSP-59+ also has 12 RTTY, AMTOR, PACTOR, G-TOR and HF packet bandpass filters centered at 2210 Hz. One of five optional center frequencies may be internally programmed for other common operating modes such as European standards or 1600-1800 Hz. HF packet. The selectable bandwidths of the bandpass filters provide optimum filtering for 170 Hz. and 200 Hz. shift data signals of various baud rates.

The DSP-59+ has individual linear phase fixed bandpass filters with steep skirts for SSTV, WEFAX and CLOVER. Since the bandwidths for these modes are fixed, the filters are primarily QRM filters for adjacent channel signals rather than noise reduction filters for eliminating random noise. The SSTV filter is a dual passband filter with one passband centered around the SSTV sync pulse at 1200 Hz, and the other passband around the varying FM picture tones from 1500-2300 Hz.. WEFAX is similar to SSTV but has no separate sync pulse so the filter bandpass covers 1500-2300 Hz. The CLOVER filter has a 500 Hz. bandwidth with a center frequency of 2250 Hz.

### **RTTY Remodulator**

The DSP-59+ has a special data function for RTTY only. After passing through the optimized RTTY bandpass filter, a precision DSP-based FSK detector in the DSP-59+ demodulates the noisy incoming RTTY tones and uses the recovered digital data to drive a precision DSP-based AFSK generator. This remodulation process takes place entirely in the DSP-59+. The precise clean tones from the RTTY AFSK remodulator can feed any analog multimode controller or TU via the DSP-59+ line audio output. Many analog RTTY demodulators have difficulty with noisy signals of varying amplitude, but virtually all of them can adequately demodulate the precise DSP AFSK generator output. The Tone (or Marker on some units) push-button selects either the remodulator with RTTY filters or the RTTY filters only.

### **Automatic Gain Control**

The DSP-59+ has switch-selectable automatic gain control to optimize the signal levels for best filter performance and to enhance listening by minimizing audible signal level variation.

### **Test Mode**

The DSP-59+ has two test modes: a self-test to verify proper operation of the DSP-59+ circuitry, and a audio signal generator mode to test other equipment. The self-test mode checks the internal digital and analog circuitry, push-button switches, LED indicators and connectors. The self-test mode not only verifies the operation of the DSP-59+, but also aids in verifying the proper installation of the DSP-59+. The audio signal generator mode produces low-distortion, precision frequency sine wave test signals at the frequency of each highpass and lowpass filter. Also, the Tone or Marker mode produces low-distortion, precision frequency sine wave signals at the center frequency of each bandpass filter. The test signals include single sine waves, two-tone signals for SSB testing, and mark-space tones for modem testing. These precision tones may be used for calibration and/or trouble shooting of other equipment the user may own.

## **2. Quick Description of Controls and Connectors**

(See Section 5, Operation for complete details)

### **Front Panel**

#### **1. Overload LED**

Red LED indicates too high signal level into DSP-59+.

#### **2. Normal**

Yellow LED indicates normal signal level into DSP-59+.

#### **3. Headphone Jack**

Stereo headphone jack for 1/8" stereo plug only.

#### **4. Bypass Switch**

Press in to Bypass DSP filtering.

#### **5. AGC switch**

Press in to activate AGC.

#### **6. HP/LP / BP**

Push-button out - Highpass/Lowpass for Voice mode. HP/LP uses blue letters.

Push-button in - Bandpass for Data and CW modes. BP uses red letters.

#### **7. Nrt / Tone Switch**

Push-button in - Heterodyne elimination for Voice (HP/LP) mode. HP/LP uses blue letters.

Push-button in - Marker Tone for CW and Data (BP) modes. Also selects RTTY Remodulator. BP uses red letters.

#### **8. NRr**

Push-button in - random noise on for Voice (HP/LP) mode. HP/LP uses blue letters.

Push-button in - random noise on for CW (BP) mode. BP uses red letters.

#### **9. High Pass / Center Freq Control**

Selects the high pass filter in the Voice (HP/LP) mode - use blue letters.

Selects the bandpass filter center frequency for CW and Data modes - use red letters.

#### **10. Low Pass / Bandwidth Control**

Selects the low pass filter in the Voice (HP/LP) mode - use blue letters.

Selects the bandpass filter bandwidth for CW and Data modes (BP) - use red letters.

#### **11. Gain / Power On/Off**

Turns power on and off, and volume control for speaker output.

### **Back Panel**

#### **12. Power In**

12-16 Volts D.C. Use 5.5 mm/2.1 mm matching plug. Center positive.

#### **13. PTI**

Switch to ground to mute speaker output in Voice mode, and to electronically bypass DSP-59+ in CW and Data modes for sidetone monitoring.

#### **14. Audio Input**

Audio input from radio speaker output.

#### **15. Line Output**

Line level output to multimode data controller. Gain control doesn't vary this output.

#### **16. Speaker Output**

4-8 ohm speaker output.

### 3. Specifications

#### AUDIO INPUT

Impedance 2 K ohms or 22 ohms, jumper selectable

#### AUDIO OUTPUT

Speaker output power 1.6 watts into 8 ohms at 13.8 VDC  
2.5 watts into 4 ohms at 13.8 VDC  
Line output -6 dB, referenced to input level, into 10K ohms. Not controlled by gain control  
Distortion less than 1% at rated output

#### NOISE REDUCTION FILTERS

	Frequency range	Attenuation	Type	Delay
Random Noise Reduction	entire freq. range of selected bandpass filter	Up to 20 dB, varies with noise characteristics. Noise reduction aggressiveness jumper programmable.	Adaptive	5 msec max
Tone Noise Reduction (multiple automatic notch)	entire freq. range of selected bandpass filter	Up to 50 dB, varies with noise characteristics	Adaptive	5 msec max

Note: The random noise reduction and bandpass filters can operate simultaneously.  
The random noise reduction, tone notch and highpass/lowpass filters can operate simultaneously.

#### CW FILTERS

CW filters	Bandwidth = 25 Hz to 600 Hz, 15 steps. Center freq. = 400 to 1000 Hz., 50 Hz. steps,	60 dB at 50 Hz outside the passband	FIR Linear phase	30 msec max
Optional Collins KWM-2 & S-Line filters	Bandwidth = 25 Hz to 600 Hz, center freq. = 1350, 1500 or 1750 Hz.	55 dB at 75 Hz outside the passband	FIR Linear phase	18 msec max
CW Marker Tone	Sine wave at center freq. of selected CW filter. Sine wave distortion less than 1%.			

#### DATA FILTERS

RTTY, AMTOR, PACTOR, G-TOR, & HF Packet	Bandwidth = 100 Hz to 600 Hz, 12 steps. Center freq. = 2210 Hz. plus option of 1700(default), 1360, 1300, 1530 or 2125 Hz.	40 dB at 60 Hz outside the passband	FIR Linear phase	18 msec max
SSTV	1100-1300 Hz & 1500-2300 Hz.	50 dB at 75 Hz outside the passband	Composite FIR Linear phase	18 msec max
WEFAX	1500-2300 Hz.	55 dB at 75 Hz outside the passband	FIR Linear phase	18 msec max
CLOVER	2000-2500 Hz.	55 dB at 75 Hz outside the passband	FIR Linear phase	18 msec max

Note: RTTY, AMTOR and PACTOR (100-350 Hz.) filters have a notch at the center frequency.

FSK Marker Tone Sine waves at mark-space freq. of selected data filter (170 or 200 Hz. shift).  
Sine wave distortion less than 1%.

## VOICE FILTERS

Highpass	Corner freq. = 200 to 1600 Hz., 100 Hz. steps.	60 dB at 180 hz. outside the passband	FIR Linear phase	18 msec max for any combination of highpass & lowpass
Lowpass	Corner Freq. = 1700 to 3400 Hz.,	60 dB. at 180 Hz.	FIR Linear	

## AGC

Voice mode	36 dB
CW and Data Modes	18 dB

## SIGNAL PROCESSING

A-D/D-A Converter	16 bit linear, sigma-delta conversion
Signal Processor	16 bit, 77ns Analog Devices ADSP-2105

## TEST MODE

Self-test	Self-test for circuitry, switches, and PTT input. User initiated from front panel.
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Test tones	Single or two-tone. Sine wave at the center freq. of each highpass and lowpass filter. Sine wave distortion less than 1%.
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## DIMENSIONS

Size	7.6 in. wide x 8.5 in. deep x 1.9 in. high (193 mm wide x 216 mm deep x 48 mm high)
Weight	2.0 lb. (0.9 Kg.)

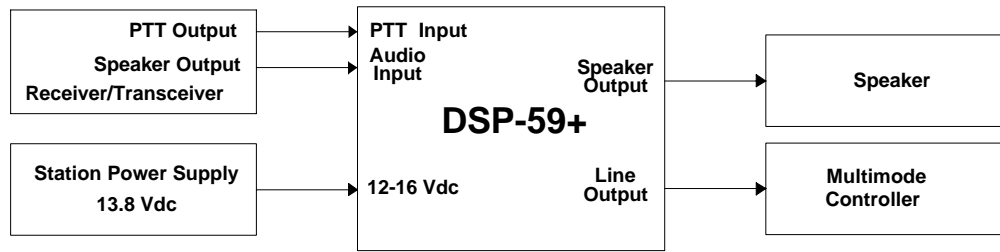
## POWER

12-16 VDC @ 1A

**Note: RTTY, AMTOR, PACTOR, G-TOR and HF Packet data filter bandwidths are specified at -3 dB points to comply with traditional data filter specification methods. All other filter bandwidths are specified to comply with conventional DSP FIR filter parametric descriptions.**

## 4. Installation

To install a DSP-59+ in a station, the operator must provide power to the DSP-59+ and make audio input and output connections to the DSP-59+. A typical DSP-59+ installation is shown below in Figure 3.1.



*Figure 3.1*

### Power Supply

The DSP-59+ requires a power source of 12 to 16 Volts dc. at 1.0 Amperes. **The center pin of the power connector is POSITIVE (+), the DSP-59+ chassis is negative. The correct power plug size is 5.5 mm o.d. and 2.1 mm i.d.**

Acceptable power sources include:

- 13.8 volt dc. transceiver power supply (recommended power source for the DSP-59+ because it is better regulated than most plug-in wall outlet supplies). **Note that some transceivers with internal power supplies have accessory power jacks with insufficient current output to drive the DSP-59+. Do not use these internal supplies!**
- Radio Shack 273-1653 12 V.d.c. @ 1 Ampere plug-in wall supply. Use green tip with center +.

(Switching power supplies are generally noisy and **not** recommended, unless they are specifically designed to drive amateur radio equipment.)

### Connecting Cables

Shielded coaxial cables with RCA phono connectors should be used to minimize the possibility of RF interference to the DSP-59+. Timewave recommends coaxial video cables with metal adapters to match the connectors on transceivers and speakers. **The center pin on the DSP-59+ audio input connector must not be connected to the transceiver speaker ground. Check the connections carefully - this is one of the most common problems in DSP-59+ installations!**



## Audio Input

The audio input of the DSP-59+ is an RCA phono connector on the rear panel of the DSP-59+. Matching the output level of the radio to the input level of the DSP-59+ is necessary to take maximum advantage of the wide dynamic range of the DSP-59+. The best way to make these levels match is to use an adjustable audio output of the radio (typically the speaker output) as the input to the DSP-59+. After connecting the DSP-59+ to the radio, follow this simple procedure to match the audio levels. First, tune the radio to a strong signal after setting the radio output level gain control to a convenient midrange position. Then, adjust the output level control on the radio so the **Overload red** indicator LED on the front panel of the DSP-59+ rarely flashes and the **Normal yellow** indicator LED always flashes with the normal audio input levels. Proper adjustment ensures optimum signal-to-noise ratio and minimum distortion. Adjust the radio output level only to maintain the proper input level to the DSP-59+. Use only the **Gain** control on the DSP-59+ to control the listening volume.

The factory default input impedance of the DSP-59+ is 22 ohms. This impedance is appropriate for most radios when driven by the speaker output of the radio. The DSP-59+ can be configured for a high input impedance by removing a shorting jumper (position 1). This jumper is accessed by removing the back bezel and the back panel of the DSP-59+.

## Audio Output

The DSP-59+ has three audio outputs:

1) On the lower left hand corner of the DSP-59+ front panel is a 3.5 mm headphone jack connected for stereo headphones. **Use of mono headphones requires a monaural-to-stereo adapter.** Direct connection of mono headphones will short the DSP-59+ audio power amplifier and may damage the DSP-59+. The DSP-59+ speaker output is muted when a headphone plug is inserted. Headphone sensitivity may vary substantially among different types. If your headphones seem too sensitive, a useful accessory is an adjustable inline attenuator (Radio Shack P/N 42-2459).

2) The Speaker Output RCA phono jack on the rear panel of the DSP-59+ provides adequate output to drive a 4 or 8 ohm speaker. The front panel gain control adjusts the audio level from this output. The maximum output power is approximately 2.5 watts into a 4 ohm speaker, or 1.6 watts into an 8 ohm speaker.

3) The Line Output RCA phono jack on the rear panel of the DSP-59+ provides adequate output power to drive a 600 ohm or greater load. **The front panel gain control does not adjust the audio level from this output.** The output level is 6 dB below the audio input level to the DSP-59+ when driving a 10 kohm or greater load. When the DSP-59+ power is switched off, the Line Output is attenuated 6 dB (this keeps the TNC level constant whether the DSP-59+ is on or off.) in level if it is driven from a low impedance source such as a receiver speaker output.

## PTTI Input

The Push-To-Talk Input electronically bypasses the DSP-59+ in the CW and data modes, and mutes the DSP-59+ in the voice mode. Use the PTTI bypass in the CW mode to hear a fixed frequency sidetone which may be different from the frequency of the selected CW bandpass filter.

Use the PTTI bypass in the voice mode to prevent unwanted transmit audio from the transceiver from causing audible interference. Many transceivers do not mute their audio outputs completely during transmit. The 36 dB extra gain from the DSP-59+ with the AGC on makes the incompletely muted transmit audio audible and may even cause oscillation by acoustic feedback from the speaker to the microphone.

A contact closure operates the PTTI circuit. No external power is required. The return (shield) side of the PTTI jack is connected to the DSP-59+ circuit and chassis ground.

Some linear amplifiers have 115 volt supplies for their transmit-receive relays. **If a transceiver PTT line is used to drive both the DSP-59+ and an linear amplifier, an isolation relay and/or isolation diode may be required to prevent damage to the DSP-59+ (and any other solid state equipment connected to the PTT line).**

## 5. Operation

### Introduction

Three knobs and five push-button switches on the front panel control the DSP-59+. Eight internal jumpers located on the circuit board near the back panel preset options for some of the front panel controls. One knob controls power and sets the speaker and headphone audio output level of the DSP-59+. The other two knobs select the filter and test generator frequencies of the DSP-59+, and control random noise reduction aggressiveness. The push-buttons select the operating modes of the DSP-59+. Note that **depressing** a push-button always selects the mode indicated **below** the push-button. Also note that if the Bypass push-button is depressed, other controls will have no effect on the operation of the DSP-59+.

### Power Switch/Gain Adjust Control

The gain knob on the front panel of the DSP-59+ is the power switch/gain adjust control. Rotate the gain control clockwise to turn on the DSP-59+ and increase the volume. Rotate the gain control counter-clockwise to turn off the DSP-59+ and decrease the volume. Turning off or removing power from the DSP-59+ automatically de-energizes a bypass relay and forces the DSP-59+ into the bypass mode.

## 5.1 Voice and Wideband Data - Highpass/Lowpass

In **HP/LP** mode, the DSP-59+ conditions the audio response of the DSP-59+ using a combination of highpass filters and lowpass filters, adaptively reduces random noise, and adaptively eliminates multi-tone noise (heterodynes). These three functions can operate simultaneously or independently as outlined below.

To activate the highpass/lowpass filter mode, place the red **HP/LP** push-button in the out position. Turn the **High Pass** control to the desired frequency indicated by the **blue** numbers around the **High Pass** control. Turn the **Low Pass** control to the desired frequency indicated by the **blue** numbers around the **Low Pass** control. These two settings customize the frequency response of the DSP-59+.

## Noise Reduction and Heterodyne Elimination

To activate heterodyne/tone elimination and random noise reduction, depress the push-buttons marked "NRt" and "NRr", respectively. Tone elimination, random noise reduction and highpass/lowpass filtering can operate simultaneously or independently. Just depress the desired combinations of push-buttons. One highpass/lowpass filter combination is always active in the highpass/lowpass mode, so set the filters for the widest bandwidth for the best frequency response.

To activate **Variable Noise Reduction (VNR)**, depress the "NRr" button if the DSP-59+ isn't already in the random noise reduction mode. Then turn the **High Pass control** straight down to the 6 o'clock position so that a tone is audible. Then turn the **Low Pass** control to adjust the amount of random noise reduction. The **High Pass** filter setting is fixed at 300 Hz in the VNR mode. The **Low Pass** filter frequency remains at its last setting before entering the VNR mode. The DSP-59+ will stay in the VNR mode until the High Pass control is moved from the 6 o'clock position. When **High Pass** control is moved to turn off the VNR mode, the noise reduction aggressiveness will remain at its last setting until it is changed or the DSP-59+ is turned off.

## Voice Bypass Mode

Depressing the **Bypass** push-button places the DSP-59+ into a bypass mode. In this mode, a relay connects the audio input jack of the DSP-59+ directly to the speaker and headphone output jacks. The relay also connects the audio input jack of the DSP-59+ to the line output jack via a 6 dB attenuator. The **Bypass** mode has precedence over the voice mode. When the DSP-59+ is in bypass, the settings of the gain control and the parameter select push buttons do not affect the signal. Turning off or removing power from the DSP-59+ automatically de-energizes the relay and forces the DSP-59+ into the bypass mode.

### **SSB Operating Hint**

Set the Highpass Filter to 300 Hz. and the Lowpass filter to 2.7 kHz. for normal sideband operation. Adjust the Highpass filter up to 500 or 600 Hz. to eliminate heavy QRM, if necessary. Adjust the Lowpass filter down to 1.9 kHz. to eliminate heavy QRM. Of course you may set them anywhere you wish, but remember that extremely narrow bandwidths will affect intelligibility, so keep the bandwidths wide, if possible.

### **Wideband Data Operating Hint**

The DSP-59+ can simulate almost any filter necessary for wideband signals such as wide shift RTTY. If you know the upper and lower audio frequency limits of the signal you are using, simply set the Highpass and Lowpass filters to pass those frequencies. The linear phase response and steep skirts of DSP-59+ will help reject QRM and improve S/N ratio. If you don't know the frequency limits, tune in a strong signal with the Highpass and Lowpass filters set to 300 Hz. and 2.7 kHz., and then tighten up the filters until the copy from the signal begins to degrade. Then back off the filters one step or until the copy is acceptable. Note these highpass and lowpass settings and use them when you operate that mode. You will have optimum QRM rejection and the best signal-to-noise ratio.

## **5.2 CW Bandpass**

In the CW Bandpass mode, the DSP-59+ tailors the audio input using one of 195 bandpass filters, and will also adaptively reduce random noise. These two functions can operate simultaneously or independently. The DSP-59+ also provides a marker tone at the center frequency of the selected CW bandpass filter.

To activate the bandpass filter mode, depress the red **BP** push-button. Turn the Center Frequency control to the desired frequency indicated by the red numbers around the Center Frequency control. Turn the Bandwidth control to the desired bandwidth indicated by the red numbers around the Bandwidth control. One bandpass filter is always active in **BP** mode.

To activate random noise reduction, depress the push-button marked "NRr". Random noise reduction and bandpass filtering can operate simultaneously or independently. Just depress the desired combinations of push-buttons.

### **CW Operating Hint**

The extremely narrow linear phase filters in the DSP-59+ will allow you to copy very weak and closely spaced CW signals. Use 25, 50, 75, and 100 Hz. bandwidths, but tune very slowly. Since many radios are difficult to tune slowly, use the bandpass center frequency control to help pick out the weak and closely spaced signals. If you are not interested in working very weak signals, tune with the bandwidth set at 150 to 600 Hz. and decrease it if you need to eliminate QRM. Use the 25 Hz. bandwidth if you are trying to copy a very slow CW signal (10 words per minute or less). EME (Moonbounce) is a typical application for the 25 Hz. filter. Random noise reduction (NRr) is especially helpful when listening to CW in the 400-600 Hz. bandwidth.

Use the **NRr** and **AGC** combination to boost the level of very weak CW signals when your receiver is at maximum gain. Some CW signals seem to magically pop out of the noise.

### **CW Marker Tone**

To activate the marker tone for CW, depress the Tone (or Marker on some units) push-button. The DSP-59+ generates an audio tone at the center frequency of the selected bandpass filter for all filters from 400 Hz. through 1000 Hz. and for the optional Collins CW filters.

## CW Bypass Mode

Depressing the Bypass push-button places the DSP-59+ into a bypass mode. In this mode, a relay connects the audio input jack of the DSP-59+ directly to the speaker and headphone output jacks. The relay also connects the audio input jack of the DSP-59+ to the line output jack via a 6 dB attenuator. The Bypass mode has precedence over the CW modes. When the DSP-59+ is in bypass, the settings of the gain control and the parameter select push buttons do not affect the signal. Turning off or removing power from the DSP-59+ automatically de-energizes the relay and forces the DSP-59+ into the bypass mode.

## 5.3 Data Bandpass

**RTTY, AMTOR, PACTOR, G-TOR, HF Packet, WEFAX, SSTV, CLOVER.**

In the data bandpass mode, the DSP-59+ tailors the audio input using one of 76 bandpass filters. The filters include a standard 2210 Hz. center frequency data bandpass filter set for RTTY, AMTOR, PACTOR, G-TOR and HF Packet, an optional data bandpass filter set for other center frequencies (preset by four internal jumpers), and 3 fixed bandpass filters for SSTV, WEFAX and CLOVER. The DSP-59+ also provides marker tones at the mark-space frequencies of the selected bandpass filter for data frequencies.

To activate the data bandpass filter mode, depress the red **BP** push-button. Turn the **Center Freq** control to the desired frequency indicated by the red numbers around the **Center Freq** control. Turn the **Bandwidth** control to the desired bandwidth indicated by the red numbers around the **Bandwidth** control. One bandpass filter is always active in **BP** mode.

The random noise reduction mode was not designed to aid data signals, but DSP-59+ users have found it helpful under some conditions. Generally, do not use the **NRr** mode with the **BP** mode for data. If noise conditions are severe, and you have tried all other filter combinations, then try the **NRr** and **BP** mode simultaneously. To activate random noise reduction, depress the push-button marked "NRr".

### **Data Operating Hint - FSK Primer**

RTTY, AMTOR, PACTOR, G-TOR and HF Packet all use Frequency Shift Keying (FSK). FSK is also called AFSK Audio Frequency Shift Keying when frequency shifted audio tones are used to modulate a transmitter. There are three important parameters used to describe an FSK or AFSK signal - the frequency shift, the center frequency, and the keying or baud rate. The combination of frequency shift and baud rate determine the spectrum of the FSK signal. The goal of a filter is to reject everything in the spectrum except the desired signal while minimizing the degradation of the desired signal.

#### **Frequency shift**

The frequency shift is specified in one of two ways. The most common specification in amateur radio is total shift or the difference between the low (Mark) and high (Space) tones. In the technical literature, the shift from a center frequency is more commonly specified. For example, a 170 Hz. shift RTTY signal is the same as a +/- 85 Hz. shift. Note the frequency shift remains the same whether it is shifting an RF signal or an audio frequency signal. Fortunately, in amateur radio, there are only two common frequency shifts - 170 Hz. and 200 Hz. 170 Hz. is the standard RTTY frequency, while 200 Hz. is the standard for AMTOR, PACTOR and G-

TOR. Unfortunately, some data converters use 200 Hz. shift for RTTY, which adds to the problem of optimally filtering data signals.

### **Center Frequency**

The center frequency of a FSK signal is independent of the frequency shift or the baud rate. In the audio spectrum, either before an AFSK signal modulates a RF signal or after the RF FSK signal is demodulated, there are several common center frequencies. In the North America, 2210 Hz. is the standard center frequency for RTTY, PACTOR, AMTOR and G-TOR, while both 1700 Hz. and 2210 Hz. share the standard for HF packet. In Europe and some other parts of the world, lower center frequencies of 1300, 1360 and 1530 Hz. are more common.

### **Baud Rate**

Baud rates vary from 45.5 baud for RTTY to 300 baud for HF packet.

For a more complete discussion of data modes, see the latest edition of the ARRL Handbook.

### **RTTY, AMTOR, PACTOR, G-TOR, HF Packet**

Normal operation for RTTY, AMTOR, PACTOR and G-TOR uses a 2210 Hz. center frequency filter (marked 2.21k in red letters by the **Center Freq** control). Use the **Bandwidth** control to select the appropriate bandwidth for each mode (RTTY - 250 Hz., AMTOR - 350 Hz., PACTOR - 450 Hz., G-TOR - 550 Hz., HF Packet - 550 Hz.).

The Option position of the **Center Freq** control selects a bandpass filter center frequency which has been preset by the internal Back Panel Jumpers. There are five optional data center frequencies - 1700 Hz. (factory setting), 1300 Hz., 1360 Hz., 1530 Hz., and 2125 Hz. There is only one Option position on the **Center Freq** control, so only one preset filter is available from the entire option set (data and CW filters).

### **RTTY Remodulator**

To select the RTTY remodulator, first chose a RTTY filter by setting the **Center Freq** control to 2.21k (red letters) or Option (red letters) to select a RTTY filter center frequency and setting the **Bandwidth** control to 250 Hz.. Then, depress the **Tone** (or **Marker** in some units) push-button to enable the remodulator. To switch the remodulator off, release the **Tone** push-button. The selected filter will remain on. The remodulator mode is easily recognized by a lack of any receiver background noise - only the pure audio RTTY tones are audible when the remodulator is on and a RTTY signal is present. The DSP-59+ mutes the audio output when it doesn't detect a RTTY signal. Normally 250 Hz. is the recommended bandwidth for RTTY; however, other bandwidths from 200 Hz. to 350 Hz. may improve copy under some band conditions.

### **HF Packet**

HF packet signals are usually centered at 1700 Hz. or 2210 Hz., depending upon the modem manufacturer. The frequency shift is 200 Hz. in both cases. If you are using 2210 center frequency (2110-2310 Hz. mark-space frequencies), select 2.21k (red letters - **Center Freq** control) and 550 (red letters - **Bandwidth** control). If you are using 1700 Hz. center frequency (1600-1800 Hz. mark-space frequencies), select the DSP-59+ Option filter (red letters - **Center Freq** control) of 1700 Hz. (factory setting) and 550 (red letters - **Bandwidth** control).

***The mark-space frequencies of the modem, receiver and DSP-59+ must match.***

Default mark-space frequency shifts and center frequencies vary among modem and radio manufacturers, and in different parts of the world. Some modems have default HF Packet mark-space center frequencies different from their RTTY, AMTOR, and PACTOR mark-space center frequencies. The DSP-59+ standard mark-space center frequency is 2210 Hz. for RTTY, AMTOR, and PACTOR data modes (use the 2.21k (red letters) position of the Center Freq. control). The DSP-59+ Option mark-space center frequency factory setting is 1700 Hz. for HF Packet mode. Use the Option (red letters) position of the Center Freq. control. ***The mark-space center frequencies of the modem, receiver and DSP-59+ must match.*** Some modems and radios have programmable mark-space frequencies. If your modem and radio default to different mark-space center frequencies, you must change the modem or radio mark-space center frequencies to match the DSP-59+ or change the DSP-59+ mark-space center frequencies to match the modem and radio mark-space center frequencies. See your radio or modem instruction manual, and the DSP-59+ Back Panel Jumper table on page 16 of this manual.

Note that some receivers do not have specific provisions to use their narrow (200 - 600 Hz wide) filters for data. Operate these radios in their SSB voice filter bandwidth. Other receivers may have fixed or variable mark-space frequencies - check your operating instructions carefully!

The Kantronics KAM+ usually has the HF Packet mark-space center frequency set to 1700 Hz. (1600-1800 Hz. mark-space frequencies). See the KAM+ manual for the procedure to change the KAM+ mark-space center frequency setting via software.

See the Back Panel Jumper Function Table on page 16 for DSP-59+ filters and settings. Jumpers 7 and 8 set the mark-space center frequencies.

#### **Data Operating Hint**

Choosing the correct bandwidth for the baud rate and shift of a data signal is critical to reject QRM while minimizing the bit error rate from noise. If there is no QRM, wide bandwidths may be acceptable on a strong signal, but could cause increased bit errors on a weak signal. Use the following settings for the best trade-off between bit error rate and QRM rejection.

Mode	Shift	Speed	DSP-59+ Bandwidth
RTTY	170 Hz.	45.5 baud	250 Hz.
AMTOR	200 Hz.	100 baud	350 Hz.
PACTOR	200 Hz.	100/200 baud	450 Hz.
G-TOR	200 Hz.	100/200/300 baud	550 Hz.
HF Packet	200 Hz.	300 baud	550 Hz.

### **Data Marker Tones**

To generate a pair of marker tones for data, set the **Center Freq** control to **2.21k** or **Option** (red lettering). Set **Bandwidth** control to 100-150 for 170 Hz. shift or 400-600 for 200 Hz. shift. Depress the **Tone** (or **Marker**) push-button to generate two continuous tones at the mark-space frequencies center around the selected center frequency. The two pairs of frequencies are the filter center frequency +/- 85 Hz. (170 Hz. shift) or the filter center frequency +/- 100 Hz. (200 Hz. shift).

### **CLOVER, SSTV, and WEFAX**

These three modes use individual fixed bandpass filters specifically designed for the each mode. Select the desired filter using the **Bandwidth** control when the **Center Frequency** control is set to **2.21k** or **Option** (red letters) in the **BP** mode. Set the **Bandwidth** control to **25** for CLOVER, **50** for SSTV, and **75** for WEFAX. (The 25, 50 and 75 Hz. bandwidth filters cannot be used for RTTY, AMTOR, PACTOR, G-TOR, or HF packet, so that use of these 25, 50 and 75 switch positions does not interfere with those modes.)

Depressing the **Tone** (or **Marker**) push-button mutes the CLOVER, SSTV, and WEFAX filters. Releasing the **Tone** push-button immediately restores the CLOVER, SSTV, and WEFAX filters to normal operation.

### **Data Bypass Mode**

Depressing the **Bypass** push-button places the DSP-59+ into a bypass mode. In the data mode, the bypass mode routes the signal through an allpass DSP filter which has precisely the same delay as the normal narrow band filter. When switching from data mode to bypass mode, this prevents a time discontinuity which can cause an AMTOR or PACTOR link to lose synchronization. The bypass mode has precedence over the Data mode. When the DSP-59+ is in bypass, the settings of the parameter select push buttons do not affect the signal.

Turning off or removing power from the DSP-59+ automatically de-energizes the bypass relay and forces the DSP-59+ into the relay bypass mode. In this mode, a relay connects the audio input jack of the DSP-59+ directly to the speaker and headphone output jacks. The relay also connects the audio input jack of the DSP-59+ to the line output jack via a 6 dB attenuator.

### **Back Panel Jumper Access**

Several options on the DSP-59+ may be preset by internal jumpers located behind the back panel. Remove the back bezel and the back panel to reach the internal jumpers. Do not remove the front metal panel or the circuit board from the DSP-59+.



Back Panel Jumper Table									
	Internal Jumper (JH1)								
Function	1	2	3	4	5	6	7	8	Setting
<b>Audio Input Resistance</b>	<b>on</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>22 ohms</b>
Audio Input Resistance	off	x	x	x	x	x	x	x	2k ohms
Voice Noise Reduction Aggressiveness (NRr)	x	on	on	x	x	x	x	x	Least Aggressive
Voice Noise Reduction Aggressiveness (NRr)	x	off	on	x	x	x	x	x	Less Aggressive
<b>Voice Noise Reduction Aggressiveness (NRr)</b>	<b>x</b>	<b>on</b>	<b>off</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>Normal</b>
Voice Noise Reduction Aggressiveness (NRr)	x	off	off	x	x	x	x	x	Most Aggressive
<b>reserved</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>on</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	
reserved	x	x	x	off	x	x	x	x	
<b>Option 1</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>x</b>	<b>on</b>	<b>on</b>	<b>on</b>	<b>on</b>	<b>1700 Hz. Center Freq. Data</b>
Option 2	x	x	x	x	off	on	on	on	1360 Hz. Center Freq. Data
Option 3	x	x	x	x	on	off	on	on	1300 Hz. Center Freq. Data
Option 4	x	x	x	x	off	off	on	on	1530 Hz. Center Freq. Data
Option 5	x	x	x	x	on	on	off	on	2125 Hz. Center Freq. Data
Option 6	x	x	x	x	off	on	off	on	1350 Hz. CW - Collins
Option 7	x	x	x	x	on	off	off	on	1500 Hz. CW - Collins
Option 8	x	x	x	x	off	off	off	on	1750 Hz. CW - Collins
Option 9	x	x	x	x	on	on	on	off	300 - 2700 Hz. Marker = 1.0 kHz.
Option 10	x	x	x	x	off	on	on	off	300 - 2700 Hz. Marker = 1.0 kHz.
Option 11	x	x	x	x	on	off	on	off	300 - 2700 Hz. Marker = 1.0 kHz.
Option 12	x	x	x	x	off	off	on	off	300 - 2700 Hz. Marker = 1.0 kHz.
Option 13	x	x	x	x	on	on	off	off	300 - 2700 Hz. Marker = 1.0 kHz.
Option 14	x	x	x	x	off	on	off	off	300 - 2700 Hz. Marker = 1.0 kHz.
Option 15	x	x	x	x	on	off	off	off	300 - 2700 Hz. Marker = 1.0 kHz.
Option 16	x	x	x	x	off	off	off	off	Reserved

**Note:** 1. "x" indicates the jumper does not affect the function or setting on its row.  
2. **BOLD** type indicates default factory setting.

## 6. Troubleshooting

### SELF-TEST

The DSP-59+ has a complete self-test feature that verifies proper hardware and firmware operation. The test has three different parts:

1. Push-To-Talk (PTT) input test.
2. Audio circuitry test
3. Front panel switch test

#### PTT Input Test

1. Connect the DSP-59+ power input jack to a 12-16 VDC @ 1 Amp. power supply.
2. Connect a normally open switch to the PTT input jack.
3. Place all the front panel push-button switches in the out position and rotate both rotary switches to the six o'clock position. Turn on the power with the power/Gain switch.
4. The “normal” and “overload” lights will flash on and off alternately.
5. Momentarily close the PTT switch. Both the “normal” and “overload” lights will stay on while the switch is pressed. The “normal” and “overload” lights will flash on and off alternately when the PTT switch is released.
6. The PTT test is complete.

#### Audio Circuitry Test

1. Temporarily remove the internal jumper in position 1. This removes the 22 ohm load resistor from the DSP-59+ input. (Remove the back bezel and the back panel to reach the internal jumpers (located behind the back panel). Do not remove the front metal panel or the circuit board from the DSP-59+.)
2. Connect a RCA phono plug to RCA phono plug jumper cable from the audio input jack to line output jack.
3. Connect the DSP-59+ power input jack to a 12-16 VDC @ 1 Amp. power supply.
4. Connect a 4 - 8 ohm speaker to the speaker output jack. Alternatively, connect mono headphones to the front panel headphone jack.
5. Place all the front panel push-button switches in the out position and rotate both rotary switches to the six o'clock position. Turn on the power with the power/Gain switch.
6. The “normal” and “overload” lights will flash on and off alternately until a switch position is changed.
7. Depress any push-button. The DSP-59+ will produce a 500 Hz. tone.
8. Depress a second push-button. The tone will change to 2000 Hz.
9. If the audio circuitry is operating correctly, the “normal” LED will be on and the “Overload” LED will be off for the duration of both the 500 Hz. tone and the 2000 Hz. tone.
10. The audio circuitry test is complete. Replace the back panel internal jumper in position 1 if it was removed in step 1.

#### Front Panel Switch Test

1. Connect the DSP-59+ power input jack to a 12-16 VDC @ 1 Amp. power supply.
2. Connect a 4 - 8 ohm speaker to the speaker output jack. Alternatively, connect stereo headphones to the front panel headphone jack.
3. Place all the front panel push-button switches in the out position and rotate both rotary switches to the six o'clock position. Turn on the power with the power/Gain switch.
4. The normal overload lights will flash on and off alternately.
5. Depress the by-pass push-button. The DSP-59+ will produce a 500 Hz. tone.
6. Depress the AGC push-button. The tone will change to 2000 Hz.
7. Release the AGC pushbutton. The tone will change back to 500 Hz. The tone will change to 2000 Hz. when any other push-button is depressed. Repeat this test until all the buttons have been tested.
8. The front panel switch test is complete.

### **Self Test End**

To end the self test , turn the power off with the volume control, rotate the rotary switches from the six o'clock position, and turn the power back to normal operating mode.

## **Common Problems and Solutions.**

### **"Normal" LED does not flash on audio peaks.**

1. Check power connection to DSP-59+.
2. Increase audio input level with receiver audio output level control until the "Normal" LED flashes.
3. Bypass the DSP-59+ by turning it off. Verify the audio level out of the radio by listening to the speaker. If nothing is heard, plug a set of **stereo** headphones into the front panel headphone jack. If no audio is heard in the headphones or speaker, check audio input connections from the receiver's external speaker output to the DSP-59+. Make sure the cable polarity is correct. See the audio input installation section.

### **"Overload" LED flashes on audio peaks.**

1. Check power connection to DSP-59+.
2. Reduce audio input level with receiver's audio output volume control, audio levels into the DSP-59+ are very important for distortion-free reception.

### **No audio output**

1. Check power connection to DSP-59+.
2. Increase audio input level with receiver audio output level control until the "Normal" LED flashes.
3. Turn the DSP-59+'s front panel audio level control clockwise.
4. Bypass the DSP-59+ by turning it off. Verify the audio level out of the radio by listening to the speaker. If nothing is heard, plug a set of **stereo** headphones into the front panel headphone jack. If audio is heard in the headphones, check the speaker connections. If no audio is heard in the headphones or speaker, check audio input connections to the DSP-59+ from the receiver.
5. Check audio output device (speaker or headphones).

If the DSP-59+ does not seem to work correctly after carefully following the installation, operation and troubleshooting instructions in this manual, call, write or FAX the Timewave Customer Service Department for additional help.

Timewave Technology Inc.  
2401 Pilot Knob Road  
St. Paul, MN 55120  
U.S.A., North America  
Phone 612-452-5939  
FAX 612-452-4571

## **7. Product Warranty**

Timewave Technology Inc. products carry the following warranty:

Timewave hardware products are warranted against defects in materials and workmanship. If Timewave receives notice of such defects during the warranty period, Timewave shall, at its option, either repair or replace hardware products which prove to be defective.

Timewave software and firmware products which are designated by Timewave for use with a hardware product are warranted not to fail to execute their programming instructions due to defects in materials and workmanship. If Timewave receives notice of such defects during the warranty period, Timewave shall, at its option, either repair or replace software media or firmware which do not execute their programming instructions due to such defects. Timewave does not warrant that operation of the software, firmware, or hardware shall be uninterrupted or error free.

The warranty period for each product is one year from date of shipment.

Limitation of Warranty: The foregoing warranty shall not apply to defects resulting from:

1. Improper or inadequate maintenance by the Buyer;
2. Buyer-supplied software or interfacing;
3. Unauthorized modification or misuse;
4. Operation outside the environmental specifications of the product;
5. Improper site preparation and maintenance.

Exclusive Remedies:

The remedies provided herein are the Buyer's sole and exclusive remedies. In no event shall Timewave be liable for direct, indirect, special, incidental or consequential damages (including loss of profits) whether based on contract, tort, or any other legal theory.

## 8. Electromagnetic Interference

**To maintain the integrity of the EMI prevention measures in this unit, it is important to replace all hardware if the unit is reassembled after opening the housing. This includes the 3 star washers around the audio input, line output and PTTI back panel jacks, the ground lugs at the sides of the PC board, and all the panel screws.**

**This unit has been tested by an independent testing laboratory to verify compliance with EMI requirements of FCC rules part 15. The following notice is required by the FCC.**

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician.

## 9. Schematic Diagrams

The schematic diagrams in this manual may differ slightly from any particular DSP-59+. Timewave reserves the right to make changes in the DSP-59+ at any time.









## APPENDIX

### Read before attempting to connect your filter.

#### Wiring information for your Timewave Audio Noise Reduction Filter model DSP-59+

This information is to help you determine which connectors you need for your receiver or transceiver. Connector requirements vary widely. Check your radio owner's manual for exact details.

#### **DSP-59+ Inputs and Outputs**

The DSP-59+ uses 4 RCA phono jacks on the back of the filter for audio input, audio output, PTTI switch, and line output. Use cables with RCA phono plugs on one end to connect to the DSP-59+. The connectors on the other end of the cables are determined by the other devices.

#### **Transceiver Speaker Output**

Most receivers and transceivers use a 1/8" mono phone jack for the speaker output. Use a cable with a 1/8" mono phone plug. The other connector is determined by the external speaker input. The most common external speaker connectors are a RCA phono jack, a 1/8" phone plug, or bare tinned wires.

#### **Multimode Data Converter and Terminal Units (TU)**

Data devices use a wide variety of connectors including phone jacks, RCA phono connectors, DIN connectors, D-subminiature, screw terminals and others. Consult your owner's manual.

#### **Transceiver PTT and T-R Outputs**

Transceiver PTT and T-R outputs use a wide variety of connectors including phone jacks, RCA phono connectors, DIN connectors, screw terminals and others. Consult your owner's manual.

Figure 1 shows a RCA phono plug and Figure 2 shows a 1/8" mono plug.

The list of pre-made cables are from the Radio Shack Store.

1. Part #42-2444 - 1/8" phone plug to RCA phono plug (DSP-59+ audio input to transceiver speaker output).
2. Part #42-2370 - phono plug to split bare tinned wire (DSP-59+ speaker output to external speaker, or DSP-59+ PTTI from a transceiver PTT output connector).
3. Part #42-2366 is a RCA phono plug to RCA phono plug.
4. Part #42-2459 Add-on volume control for lightweight stereo headset cord with a stereo 1/8" plug.

Figure 1

Figure 2

For more information see your ARRL Handbook on connectors.